IMU-3000 3-Axis Gyro Evaluation Board
Application Note

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1. Revision History

Date	Revision	Description
May 18 2010	01	Initial release
May 25 2010	01A	R15 set to 1kohm
June 23 2010	01B	R23 set to 100k

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2. Purpose

This document describes the hardware and circuitry on the IMU-3000 3-Axis Evaluation Board (EVB). It includes applying the EVB to a larger system, understanding the key signals and circuit functions, hardware jumper settings, and port connectors.

2.1 Usage

This evaluation board provides six axes of motion processing, comprised of:

- IMU-3000 with integrated three-axis gyro with ±250 to ±2,000 °/sec full-scale range
- Kionix KXTF9 three-axis accelerometer whose outputs are connected into and whose sensor data is processed by the IMU-3000
- A header connector with I^2C interface connects to the host processor to run the IMU-3000
- A socket is provided for the AKM AK8975 3-axis compass, and its outputs are connected to main I^2C interface.

The Evaluation Board may be used independently with any host processor using the I^2C serial communications interface. When the IMU-3000 is evaluated using Windows PC demonstration software, it is connected via InvenSense's ARM Evaluation Board (INV-ARMEVB). This allows a bridge between I^2C interface and the host Windows PC USB interface, allowing the PC demonstration software to run.

2.2 Related Documents

The following documents are recommended for a more comprehensive understanding of the components and systems described in this Application Note.

- IMU-3000 Product Specification

3. IMU-3000 3-Axis EVB Overview

The IMU-3000 3-Axis EVB contains the IMU-3000 3-axis digital gyroscope, a Kionix KXTF9 3-axis accelerometer and their interface circuitry. It contains removable and "solder-across" jumper points that permits several circuit configurations.

Referring to Figure 1, the EVB is populated on its top side only for ease of measurement access. The 20-pin (10 x 2) Main header connector is designed to interface with the InvenSense INV-ARM EVB, which is a host microcontroller board useful for adapting the IMU-3000 6-Axis EVB to a personal computer via its USB port.

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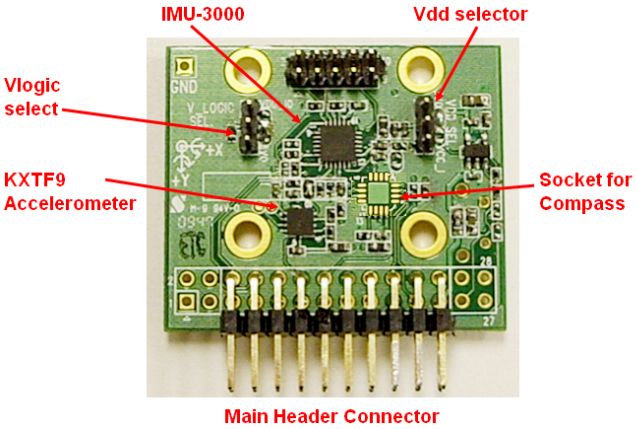

Figure 1. Top side of the IMU-3000 3-Axis EVB

The 10-pin (5 x 2) Factory extension header is intended for connecting additional devices to the EVB, such as a digital-output barometer, etc. One 3-pin power selection header is used to select which voltage supply is interfaced to the IMU-3000, and the other selects the I^2C Vlogic level.

The Power select jumper allows the IMU-3000 Vdd to be supplied either directly from a 3.3V DC input on the main header, or by a local 3.0V voltage regulator.

3.1 IMU-3000 Key Function and Pin-outs

The following documents are recommended for a more comprehensive understanding of the components The IMU-3000EVB is a fully-tested board, providing a quick evaluation of the IMU-3000 motion processing capability. The IMU-3000 uses InvenSense's proprietary MEMS technology with vertically driven vibrating masses to produce a functionally complete, low-cost motion processing system. All required conditioning electronics are integrated into a single chip measuring 4 x 4 x 0.9mm. It incorporates X-, Y-, and Z-axis low-pass filters and an EPROM for on-chip factory calibration of the sensor. Factory trimmed scale factors eliminate the need for external active components and end-user calibration. A built-in Proportional-To-Absolute-Temperature (PTAT) sensor provides temperature compensation information. The product is lead-free and Green Compliant. Refer to the IMU-3000 Product Specification for a complete description.

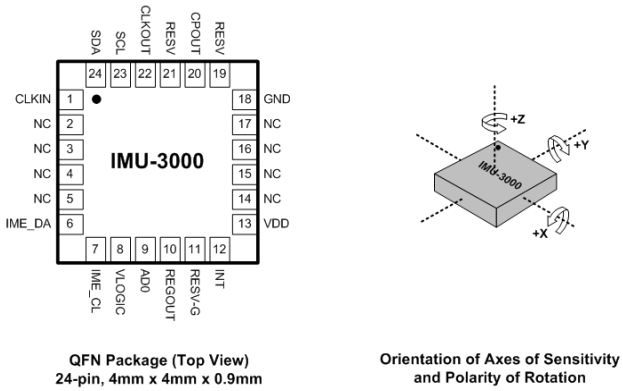

Figure 2. Top View Pin-Out and Sense Orientation of the IMU-3000

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3.2 IMU-3000 Functional Block Diagram

The IMU-3000 consists of a MEMS gyroscope, a data-acquisition and digital signal processing section, and a data interface which is compatible to I^2C. The data interface is a slave. It also has a secondary I^2C compatible port master, which can be either a pass-through from the host primary I^2C port, or it can be locally mastered by the IMU-3000 to get accelerometer data. This allows the IMU-3000 to synchronously sample and process 6-axis sensor data without a host processor.

Vdd and Gnd are the main supply voltage connections, and Vlogic is an input which sets the data interface logic-high level. This allows Vdd to be different than Vlogic, so that as an example, Vdd could be 2.6VDC while the data interface connects to a 1.8V I^2C bus. Vregout is for connecting the (nominally) 1.7V internal voltage - regulator to a bypass capacitor. CPout is for connecting a charge pump capacitor to the internal 25V charge pump.

The INT pin is the IMU-3000 interrupt and may be software configured to a variety of modes. AD0 is the LSB of the I^2C device address, so that when it is tied logic-low, the IMU-3000 address is 68h, and when logic-high (Vlogic) the IMU-3000 address is 69h.

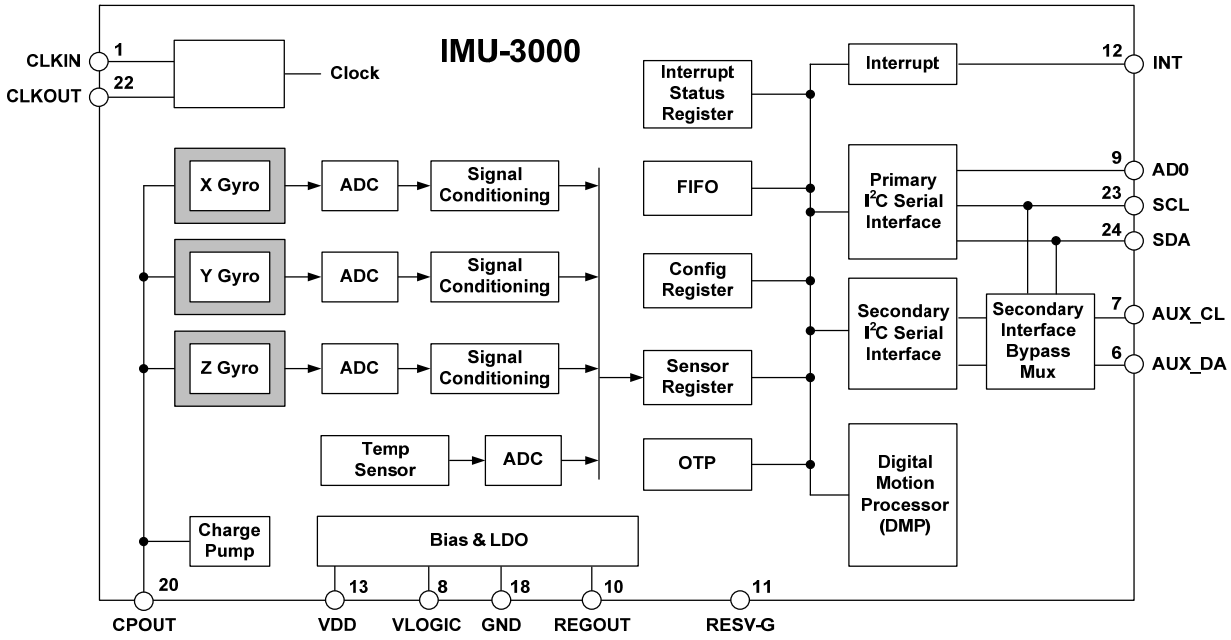

Figure 3: IMU-3000 Functional Block Diagram

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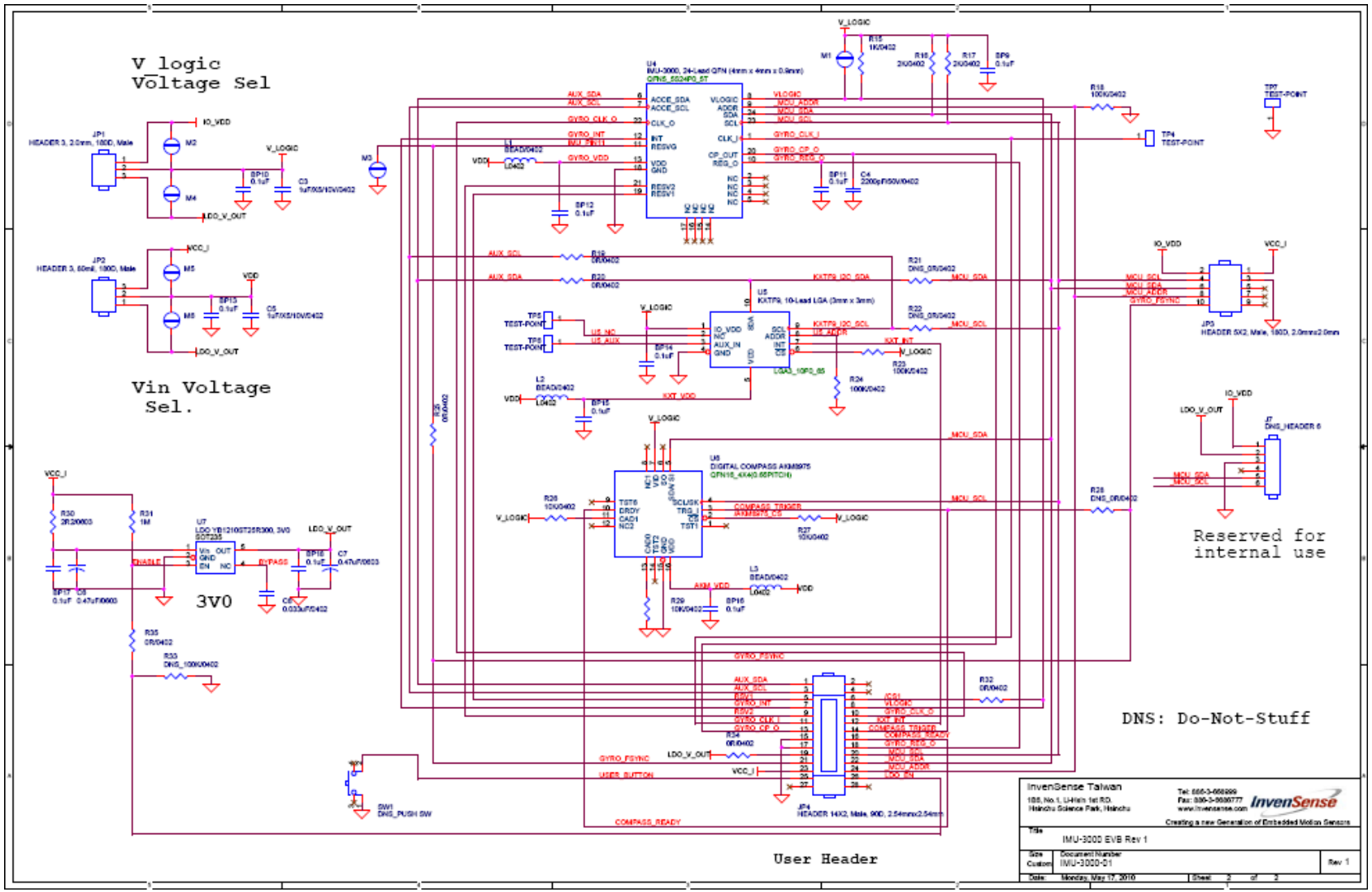
3.3 IMU-3000 Evaluation Board Schematic



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3.4 Bill of Materials (Parts Stuffing List) for IMU-3000 EV Board

Parts Stuffing BOM for IMU-3000 EV Board. Also refer to Assembly Drawing for IMU-3000 EV Board

Item	Reference	Part Number	Instructions	Manufacturer	What this does	Qty
1	BP9,BP10,BP11,BP12,BP1					
	BP14,BP15,BP16,BP17,BP	0.1uF		generic		10
2	C3,C5	1uF 10V 0402		generic		2
3	C4	2200pF 50V 0402		generic		1
4	C6,C7	0.47uF 0603		generic		2
5	C8	33nF 0402		generic		1
6	JP1	Male		generic	Vlogic select	1
7	P1	Jumper, 2pin 2mm	jumper on JP1 pins 1-	generic	set Vlogic to 3.3V Host pro	1
8	JP2	Male		generic	Vinput select	1
9	P2	Jumper, 2pin 2mm	jumper on JP2 pins 1-	generic	set IMU-3000 Vdd to 3V loca	1
10	JP3	Male		generic		1
11	JP4	Male			main I/O header	1
12	J7	HEADER 6	do not stuff	generic		1
13	L1,L2,L3	Ferrite Bead 0402	can be 0 ohm resistor	generic		3
14	R15	1K/0402		generic		1
15	R26,R27,R29	10K/0402		generic		3
16	R16,R17	2K/0402		generic		2
17	R18,R23,R24	100K/0402		generic		3
18	R21,R22,R25,R28, R32	0R/0402	do not stuff	generic		5
19	R19,R20,R34,R35	0R/0402		generic		4
20	R30	2R2/0603		generic		1
21	R31	1M/0402		generic		1
22	R33	100K/0402	do not stuff	generic		1
23	SW1	Pushbutton SW	do not stuff	generic		1
24	TP5,TP6,TP7	TEST-POINT	do not stuff	generic		3
25	U4	IMU-3000		InvenSense	3-axs Gyroscope	1
26	U5	KXTF9		Kionix	3-axis Accelerometer	1
27	U6	AK8975	do not stuff	AKM	3-axis Compass	0
28	U7	YB1210 ST25R300, 3V0	this is a 3V LDO	Yoban	local 3V supply to the EV B	1
29	M2	solder-across jumper	do not solder across	PCB feature	sets Vlogic to I/O Vdd	0
30	M4	solder-across jumper	do not solder across	PCB feature	sets Vlogic to on-board LDO	0
31	M5	solder-across jumper	do not solder across	PCB feature	sets Vinput to Vcc_In	0
32	M6	solder-across jumper	do not solder across	PCB feature	sets Vinput to on-board LDO	0
33	M3	solder-across jumper	solder across	PCB feature	sets pin IMU-3000 11 to ground	1
34	M1	solder-across jumper	solder across	PCB feature	sets /CS Vlogic pin 8 to Vlogic mode	1

Table 1. Parts Stuffing List the IMU-3000 EVB. Only the Top Side Requires Component Assembly.

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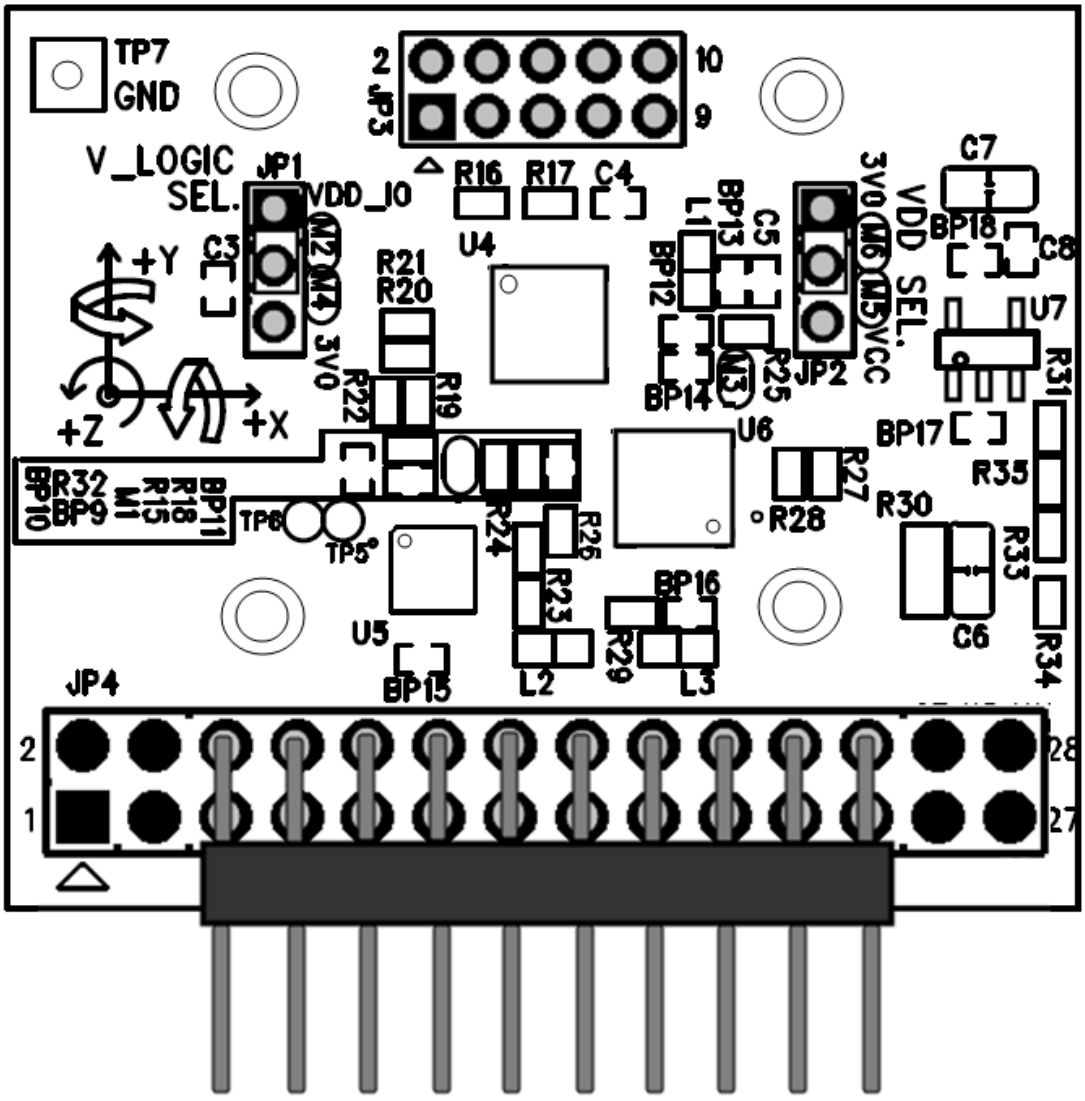
3.5 Assembly Drawing for IMU-3000 EV Board

Figure 4. IMU-3000 EV Board Assembly Drawing. Follow the Parts Stuffing List for assembly instructions.



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3.6 Power Supply Connections

JP1 and JP2 are 3 header-pin plug-in jumpers which allow users to select between the on-board LDO and an external DC supply to the IMU-3000 and other sensors on the board. For details, please refer to Table 2. Power Selection Jumpers.

The on-board 3.0V LDO (Low-dropout voltage regulator) is a low-noise part. Its output is called 3V0 on the schematic, and using it will assure that the gyroscope and accelerometer performance will meet intended specifications.

Selecting the raw Vcc line to power the chip is generally done while designing and evaluating with an embedded platform, where the host processor and related electronics need full control over the motion processing chip's power supply. When the user intends to use on board LDO 3V0 power, the external Vcc must be higher than 3.2V to ensure the LDO works properly. If the user provides Vcc with 5V, JP2 and JP2 must be set as "1-2 short" to enable the on-board 3.0V LDO. The IMU-3000 VDD and VLOGIC operation range is 2.1V to 3.6V. The Kionix KXTF9 accelerometer operates from 1.8 to 3.6VDC.

3.7 IMU-3000 EVB Connector Signals Description

Table 2. Power Selection Jumpers (use P1, P2 to short pins as required)

JP1 Pin Number	Signal Description
1-2 short	IMU-3000, KXTF9 VLOGIC = 3V using on board LDO
2-3 short	IMU-3000, KXTF9 VLOGIC = Vcc (from external)
JP2 Pin Number	**Signal Description**
1-2 short	IMU-3000, KXTF9 VDD = 3V using on-board LDO
2-3 short	IMU-3000, KXTF9 VDD = Vcc (from external)

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Table 3. "Main Header" User Interface Signals

JP8 Pin Number	Signal Description
1	KXTF9 Accel AUX_SDA when R19 is stuffed
3	KXTF9 Accel AUX_SCL when R20 is stuffed
5	NC
7	INT, IMU-3000 pin 12 Interrupt output to host controller
9	NC
11	CLK_IN, IMU-3000 pin 1 external clock input
13	CPOUT, IMU-3000 pin 20 (charge pump capacitor)
15	GND
17	GND
19	3V on-board LDO (regulated DC) output
21	NC
23	Vcc (from ARM-7 Controller Board) or external 3.3V at >100mA
25	Push-button switch to ground (not normally stuffed)
27	NC
2	NC
4	NC
6	NC
8	Vlogic DC Input, IMU-3000 pin 8 (sets I^2C bus logic levels)
10	NC
12	NC
14	AKM8975 Compass trigger input (part not normally stuffed)
16	AKM8975 Compass data-ready (part not normally stuffed)
18	REGOUT, IMU-3000 pin 10 (on-chip regulator bypass capacitor)
20	Primary SCL, IMU-3000 pin 23 is I^2C clock line
22	Primary SDA, IMU-3000 pin 24 is I^2C data line
24	AD0, IMU-3000 pin 9 I^2C Address bit zero
26	EVB on-board 3V LDO enable (when pulled to Vcc)
28	NC

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Table 4. Extended Factory Connector pin functions

JP3 Pin Number	Signal Description
1	Vcc, power from INV-ARM board or external 3.3V at >100mA
3	GND
5	NC
7	NC
9	NC
2	3V
4	SCL, IMU-3000 I^2C clock line
6	SDA, IMU-3000 I^2C data line
8	ADO, IMU-3000 I^2C Address bit zero
10	NC

3.8 Serial bus Levels, Speeds and Terminations

The IMU-3000 supports fast mode I^2C up to 400kHz clock The I^2C bus open-drain pull up resistors are R2 and R3 for SDA and SCL; both are 2.2kohm connected to either 3.0V or the externally provided Vcc. The pull up level is selected by JP2. Please refer to Table 2. Power Selection Jumpers.

3.9 Solder-Across "M" Jumpers

For fast and permanent configuration connections, a set of solder-across jumpers are provided.

3.10 Table 5. Solder-Across "M" Jumpers – what they do and how to connect

M Number	M Jumper function
1	Pulls IMU-3000 VLOGIC pin 8 to Vlogic supply. It is in parallel with R15
2	Shorts JP1 pins 2-3 to set IMU-3000 VLOGIC = Vcc externally supplied voltage
3	Shorts IMU-3000 pin 11 to ground. Should be soldered-across.
4	Shorts JP1 pins 1-2 to set IMU-3000 VLOGIC = 3.0V using on board LDO
5	Shorts JP2 pins 2-3 to set IMU-3000 VDD = Vcc externally supplied voltage
6	Shorts JP2 pins 1-2 to set IMU-3000 VDD = 3.0V using on board LDO

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4. Data Gathering Options

The IMU-3000 Digital Sensor Data is available at the Main Header connector. For connecting to a host PC to run the demonstration software, an InvenSense INV-ARM Interface Board must be used. PC demonstration software is not covered in this Application Note.

4.1 Connection to INV-ARM Interface EVB

The photo shows the connection of IMU-3000 to INV-ARM EVB. Connection between the two boards is made via the main header connector.

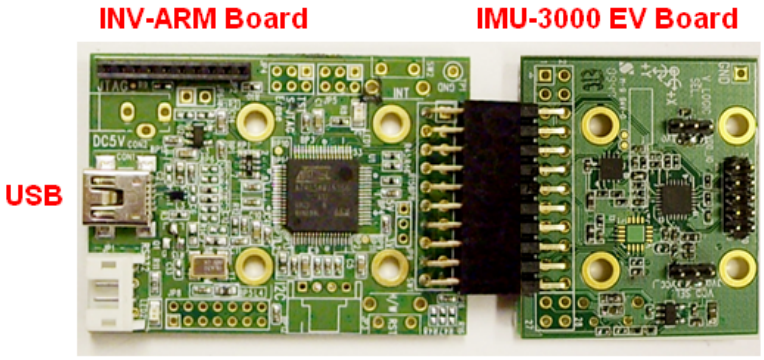

Figure 6: Connect IMU-3000 to ARM Board

The INV-ARM serves as an I^2C to USB converter. An Atmelo ARM7 microcontroller is programmed to serve the following functions:

- Sends data through the USB link at 115.2kbps
- Provides an I^2C port Master to the IMU-3000 or other InvenSense digital gyro
- Handles interrupts from the gyro, accelerometer and compass devices on the EVB
- Allows a two-way path for the PC to send commands to the IMU-3000, and send back the resulting data

The firmware inside the INV-ARM at time of publication is V1.10.

4.2 Use of IMU-3000 without ARM EVB board

I^2C signals are available on JP8. The user may develop tools to communicate with the IMU-3000. There is no bus mode selection setting required.

5. Special Instructions

5.1 Electrostatic Discharge Sensitivity

The IMU-3000 gyro can be permanently damaged by an electrostatic discharge. Proper ESD precautions for handling and storage are recommended.

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6. Mechanical Dimensions

The IMU-3000 EVB is a 4 layer PCB with 32mm x 38mm overall dimensions. The mounting holes are arranged to fit 19.56mm x 18.54 mm fixture screw centers, offset from the edge of the board by 9.22mm and 3.05mm as shown.

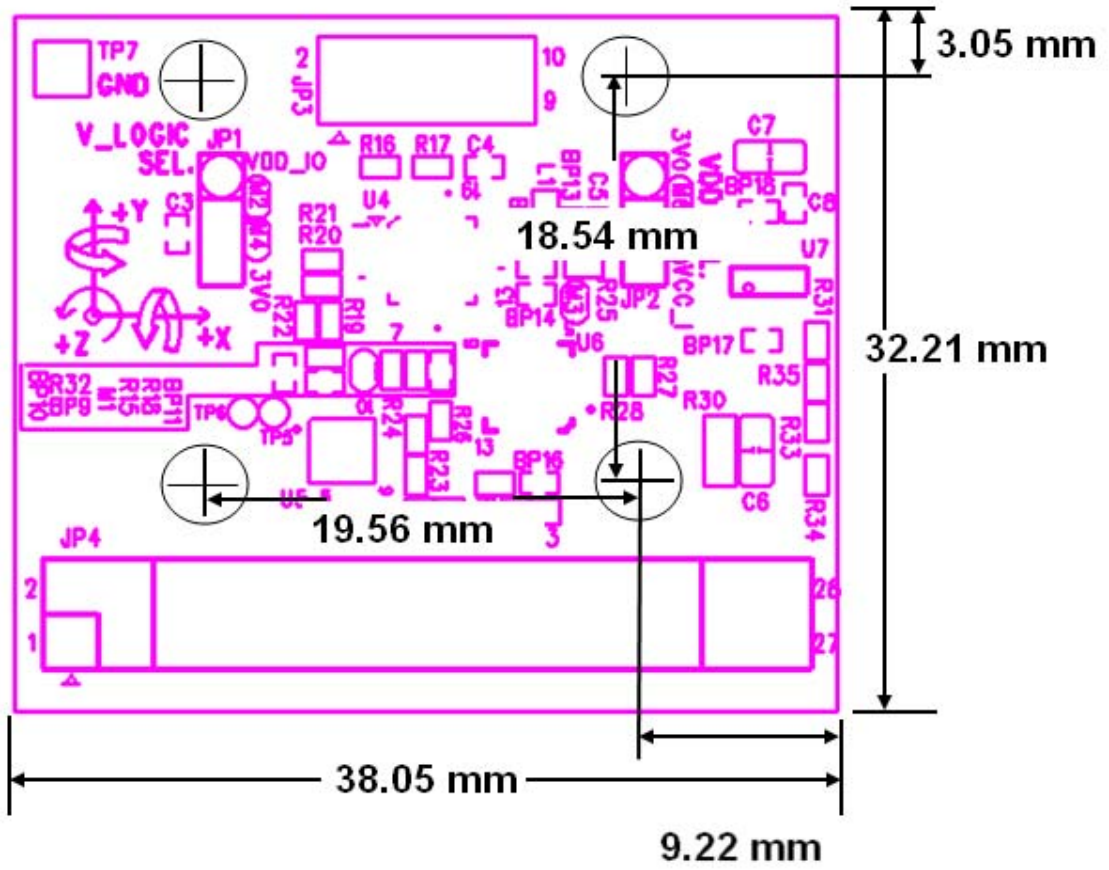

Figure 7: IMU-3000 Dimensions, Top Side shown

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